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Letter to the Editor

Effects of exercise and/or sleep deprivation on anxiety—Like behavior and body weight of female rats

The precise performance of sleep on brain health is not identified, although it is widely established that sleep has a basic performance in natural body function especially, central nervous system (CNS) recovery (Luyster et al., 2012). Fragmented sleep and sleep disorders in the long time can cause emotional changes, impaired cerebral capability, and disrupted function (Curcio et al., 2006). For instance, many experimental studies have indicated that SD causes damages in cognitive performance (Saadati et al., 2015, 2014a, 2014b; Salari et al., 2015), emotional memory (Fernandes-Santos et al., 2012) and increased anxiety levels (Vollert et al., 2011).

As well as, sleep loss is a frequent complaint of women compared with men. In addition, sleep difficulties are reported to be more frequent during the menopausal and post-menopausal periods in women (Dzaja et al., 2005; Luyster et al., 2012)

Vast body of evidence revealed that aerobic running is a helpful and cost-well-organized treatment for several of anxiety and mood disorders, such as anxiety like behavior (Cotman and Berchtold, 2002). The purpose of this study was to specifically test the effects of chronic physical exercise and/or sleep deprivation on anxiety-related behaviors in female rats.

Female Wistar rats (3–4 month old, weighing 200–250 g) were employed for the current study. Two sets of rats containing intact and ovariectomiezed (OVX) were assigned into the subsequent subgroups at random: control, SD, wide platform (Sham group-WP), exercise, sham exercise and exercise/SD (n = 8 for each group).

The exercise protocol was four weeks running from Saturday to Wednesday and the multiple platform apparatus was applied to make 72 h sleep deprivation (Saadati et al., 2014a, 2014b). Anxiety-like behaviors were determined using open field test (Vollert et al., 2011). Two-way ANOVA, a Tukey's post hoc multiple comparison and –sample *t*-test tests was used for all comparisons among the groups.

Our results indicated that there was a significant difference between groups only in two measured parameters: the mean number of rearing ($F(11, 76) = 3.8$, $p < 0.001$) and time spent in the center of arena ($F(11, 76) = 3.5$, $p < 0.01$) .Sleep deprived animals (intact and OVX groups) showed a significant decrease in number of rearing when compared to the exercise/SD ($p < 0.001$) and other groups ($p < 0.05$). Exercised groups [exercised and exercised/SD (intact and OVX) groups] spent longer time in the center of the arena ($p < 0.05$) in compared with the other groups. Exercise and sleep deprivation did not affect total distance moved and these parameters in SD and exercised groups were not different from control groups (Table 1).

Table 1
The effects of exercise and sleep deprivation on anxiety like behavior and mean body weight of female rats.

	groups	Time in inner zone (s)	Total distance moved (cm)	Number of rearing
Intact groups	Control	12.82 ± 2.18	2884.01 ± 247.62	21.88 ± 1.33
	SD	13 ± 2.5	2748.25 ± 122.23	11.83 ± 1.35*** ‡
	Exercise	28.13 ± 3.6*	2698.68 ± 63.23	22.14 ± 1.81
	Exercise/SD	30 ± 3.1*	2804.13 ± 236.75	22.28 ± 3.20
	Sham exercise	13.3 ± 1.8	2750.54 ± 176.27	21.43 ± 1.43
	WP	12.54 ± 1.38	2799.81 ± 121.52	23.87 ± 1.9
OVX – groups	Control	11.07 ± 1.05	2832.48 ± 252.97	21.38 ± 1.3
	SD	14.25 ± 1.65	2772.30 ± 200.47	13.5 ± 1.2*** ‡
	Exercise	27.43 ± 2.55*	2581.52 ± 99.69	23.86 ± 2.84
	Exercise/SD	25.39 ± 3.9*	2680.30 ± 104.47	24.28 ± 2.39
	Sham exercise	10 ± 2.92	2647.29 ± 150.32	20.4 ± 2.98
	WP	14.05 ± 1.31	2780.49 ± 120.78	20 ± 1.41
weight				
Intact	Groups	Pre-SD	Post-SD	
	SD	218.5 ± 3.57	200.37 ± 3.12***	
	Exercise/SD	224.75 ± 3.61	204.375 ± 4.41*	
OVX	SD	218.25 ± 4.96	198.125 ± 4.63***	
	Exercise/SD	230.22 ± 5.94	209.22 ± 5.42***	

The effects of regular treadmill exercise and sleep deprivation (SD) on anxiety like behavior and mean body weight of different groups. Data are shown as mean ± S.E.M. (***) $P < 0.001$ and (*, ‡) $P < 0.05$ indicating the significant differences with exercise/SD and the other groups respectively (8 rats/group). For comparison between pre- and post-experiment body weight, a paired-sample *t*-test was used (*) $P < 0.05$, (***) $P < 0.001$.

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In order to examine the effect of SD and/or exercise also experimental condition (wide and narrow platform and treadmill) on the animals' body weight, we measured the body weight before and 72 h after placing on the wide and narrow platform and during exercise. As shown in Table 1, SD had a reducing effect (SD-Intact: $p < 0.001$ and exercise/SD intact: $p < 0.05$; SD-OVX and exercise/SD-OVX: $p < 0.001$) on the mean body weight. However, there was no significant difference between the pre and post body weight values in all the WP as well as exercised nave and sham groups (results not shown).

Our results suggest that 72 h SD increased anxiety-like behavior of rats in the open-field test as display by reduced rearing. Exercised sleep-deprived rats did not display anxiety-like behavior as compared to SD alone rats suggesting that treadmill exercise had a protective effect. As well as regular exercise used in this experiment resulted in prevention and decreasing of anxiety-like behavior in animals.

In addition, our previous findings demonstrated that female animals are more sensitive to the harmful effects of sleep deprivation on cognition (Hajali et al., 2015a, 2015b; Saadati et al., 2015, 2014a, 2014b; Salari et al., 2015). Interestingly, running exercise well-known as a general mood elevator in humans (Cotman and Berchtold, 2002), is reported to diminish the increasing oxidative stress in the brain. On the whole, several experiments explain a relation of regular running, mental health and anxiety in humans. In addition, it was earlier revealed that physical exercise could standardize serum corticosterone level and decrease anxious behaviors induced by sleep loss in male animals (Vollert et al., 2011).

Our findings revealed that pre- and post- body weight of animals in present study and plasma corticosterone levels of sham (WP) experimental groups in previous study (Saadati et al., 2015) are not significantly meaningful, it could be believed that the weight loss detected in the sleep deprived rats does not associated with a non-specific states, such as novelty or restriction stress effects. However, there was no significant difference in mean body weight among exercise, control and sham groups and the data of these groups were not presented.

Conflict of interest

The authors declare that there are no conflicts of interest in our study.

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Saadati Hakimeh*
Sheibani Vahid
Department of Physiology, Faculty of Medicine, Ardabil University of Medical Sciences, Ardabil, Iran

Neuroscience Research Center, Institute of Neuropharmacology, Kerman University of Medical Sciences, Kerman, Iran

* Corresponding author.
E-mail addresses: hsadat54@yahoo.com,h.saadati@arums.ac.ir (S. Hakimeh).

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